2283. C. Hanford Henderson, Ph.D., Philadelphia.
2284. Chas. Sedgwick Minot, Harvard Univ., Mass.
2285. L. H. Bailey, Ithaca, N. Y.
2286. Wm. H. Welch, M.D., Baltimore, Md.
2287. T. Mitchell Prudden, M.D., New York City.
2288. John Trowbridge, Harvard Univ., Mass.
2289. Nikola Tesla, New York City.
2290. Arthur W. Wright, Ph.D., New Haven, Conn.
2291. Prof. Henry A. Rowland, Baltimore, Md.
2292. Prof. Arthur W. Goodspeed, Philadelphia.
2293. Prof. Michael I. Pupin, New York City.
2294. Thos. A. Edison, Orange, N. J.
2295. Edw. C. Pickering, Cambridge, Mass.
2296. Frank H. Cushing, Washington, D. C.

The Joly Process of Color Photography.

By Julius F. Sachse.

(*Read before the American Philosophical Society, May 15, 1896.*)

I have the honor to present to your notice this evening, by courtesy of Mr. Richard Barkley, of New York, a series of specimens illustrating the so-called "Joly" process of color-photography.

They are the same as were lately shown before the Royal Society of England, and excited considerable attention.

This process, although it depends upon the three primary color sensations, differs materially from all others thus far brought to the notice of the public, because but a single photographic manipulation is required, and no apparatus is needed other than such as is used in ordinary every-day photography.

This process consists in making a negative through a closely-lined screen, ruled in three colors, viz., orange, yellow-green and blue-violet. The screens used in the specimens here shown were made with an ordinary ruling pen, such as is used by draughtsmen, and the lines number about two hundred to the inch. A finer ruling in the future will make the lines which we now see in the specimens before us less prominent.

It will be noticed that Prof. Joly, in his "taking" screen, which is here before you, has substituted, for the usually accepted primary color

sensations, red, green, blue, the colors orange, yellow-green and blue-violet. Experience has taught him that not only were the former colors unsuitable for the purpose, but that to reproduce the effect of natural colors, a somewhat different screen must be used over the resultant positive image. For this purpose Prof. Joly rules a screen in pure red, green and blue-violet. This he calls his viewing screen.

[For the red-selecting lines of the "taking" screen, Prof. Joly uses a spectrum color, such as that to be found at one-sixth of the distance from the line D to the line C; for the green-selecting lines he uses a color corresponding to that of the spectrum at about one-third of the distance from the E line to the D line; and for the blue-violet-selecting lines he uses a color corresponding to the spectrum color near the F line, but toward the G line. On comparison of the "taking" screen with the spectrum, these colors can be called a red-orange, yellow-green, and a violet-blue. For the colors of the "viewing" screen he uses a pure red not far from the C line; a green near the E line; and for the blue-violet lines he takes a spectrum color between G and H, the object being in the "viewing" screen to transmit fundamental color sensations only, and to let the eye do its own mixing; the eye is assisted by the depth of light and shade in the linear areas of the positive; for instance, if the full amount of light of two adjacent red and green lines be transmitted, the eye sees a yellow; if now some of the green be obstructed or shut out by the positive over it, then the eye will see an orange; and if, on the other hand, some red be shut out by the positive, then the eye sees a yellow-green, and it is easy to see that one can run all the colors from pure red to pure green by the varying amounts of the red or green lines shut out by the positive.]

The first specimen we have here is a negative of a china plate and jug, photographed through the "taking" screen.

The next one is a glass positive printed in contact from the above negative. It will be noticed that neither of these specimens differ from ordinary photographic results except that lines due to the use of the screen are somewhat prominent.

The third specimen is a positive similar to the one just shown, placed in register with a "viewing" screen; and by holding it up to the light, and viewing it through the ruled grating, we see the china plate and jug in the bright colors of the original objects.

The next subject is a male portrait from life; this illustrates the possibility of the process in its application to professional portraiture.

We now have a portrait of an "Irish peasant girl," not from life, it is true, but from a water color, which is here before us. The specimen labeled No 7 is placed in contact with a "viewing" screen. The original is here offered for comparison, so that you may judge of the fidelity of the reproduction to the colors of the original. To prove the correctness of his theory, Prof. Joly here presents another specimen of the same subject, No. 12. This is taken and placed in contact with the same

("taking") screen. The great difference and the falsity of the color rendering will at once be noted by comparison with the original.

The next specimen is perhaps the most interesting one of all, on account of being an almost instantaneous picture.* It represents a military band in the Park of Trinity College, Dublin. It will be noted that the bright reds of the uniform coats are exceptionally well rendered. Further, this example indicates a possible application of this method of color reproduction to snap-shot photography.

I now wish to call your attention to an interesting feature of this process, viz., the necessity for having the photograph and screen in exact register, and viewing it in a normal position. Viewed direct, this transparency shows the colors of nature: the brilliant red hue of the coats is especially noticeable. Now if we turn the transparency so as to view it at a slight angle, we at once note a change of the colors, and, in this particular instance, an apparent change of the nationality of the subjects: in place of English soldiers in bright red coats, we see a body of men dressed in brilliant green: in short, the Englishman appears to have been turned into an Irishman of the most pronounced type.

The next subject is a perfect representation of a green fluorescent bowl made of uranium glass.

We now come to another interesting specimen—a photograph of a bunch of wall flowers, executed in two color sensations only, viz., the red and green sensations. This picture derives an additional interest from the fact that it was made by Prof. Joly at the request of Lord Kelvin, to show the effect of "violet blindness," an extremely rare variety of color-blindness.

I now present to your notice two photographs of the solar spectrum from nature—the first one made through a "taking" screen, and seen through a "viewing" screen, which, as you will perceive, shows some of the principal lines; the other one, both taken and viewed through the "viewing" screen, shows a false color rendition. The yellow passing through the red lines only, is almost entirely represented by pure red. The incorrectness of the result is evident on comparing it with the first specimen or with nature.

I now come to the commercial part of this process. I have here for your inspection a specimen of three-color printing: the original photograph consists of a single negative; the printing was done from three separate half-tone blocks or plates—red, yellow and blue.

This result is obtained by making three positives in the camera from the original negative in the following manner: A special screen is prepared with black lines twice the width of those upon the taking screen, the intervening space being the width of a single line. This screen, when placed in register with the original negative, it will be observed, exposes only every third line of the negative. Now it will be obvious that if this screen be moved the width of a single line before each

*Actual time about three seconds.

exposure, we shall obtain three positives, each showing but one-third of the original negative, and at the same time representing a different color sensation. An ordinary half-tone plate is now made from each positive, in the usual manner, and then printed successively in yellow, red and blue inks, the same as in the ordinary chromo-typographic or three-color process.

In the case under consideration you will note the almost perfect result, without the presence of the objectionable mathematical cross-line hatch-work.

This latter adaptation of the Joly process, I am informed, is the invention of two young men in this country; and should it prove practical and give certain results, it will without doubt be a great step forward in chromo-typography, and also have commercial value.

It is a curious fact that the foundations of the interesting processes I have described are based, and depend for their ultimate success, upon the ruling machine—an invention of Joseph Saxton, a former member of this Society, specimens of whose early photo-mechanical reproductions, made in 1841, are still in our possession.

In conclusion, I will state that the one great advantage which this process seems to offer over other schemes in heliochromy or the three-color process, is the fact that but a single negative is required, which is obtained by the ordinary methods of photography, so that all special or intricate apparatus, with uncertain results, are obviated. It will be further noted that the specimens shown here to-night are among the earliest ones made, with crude appliances as to the ruling of the screens and the pigments.

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*Second Contribution to the History of the Cotylosauria.**

By E. D. Cope.

(*Read before the American Philosophical Society, May 15, 1896.*)

The examination of new material derived from the Permian formation of Texas enables me to make some important additions to the knowledge of the Cotylosaurian Reptilia, as set forth in my synopsis published in these PROCEEDINGS for November, 1895 (p. 437).

In the first place, I have to describe a type new to the order, and which resembles nothing hitherto found in the Permian beds of North America, or apparently elsewhere. It must be referred to a new family with the following name and characters.

* Read before the U. S. National Academy of Sciences April, 1896.